Algorithm Theoretical Basis Document
GSICS GEO-AIRS (Details)

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Algorithm Theoretical Basis Document
GSICS GEO-AIRS Inter-Calibration

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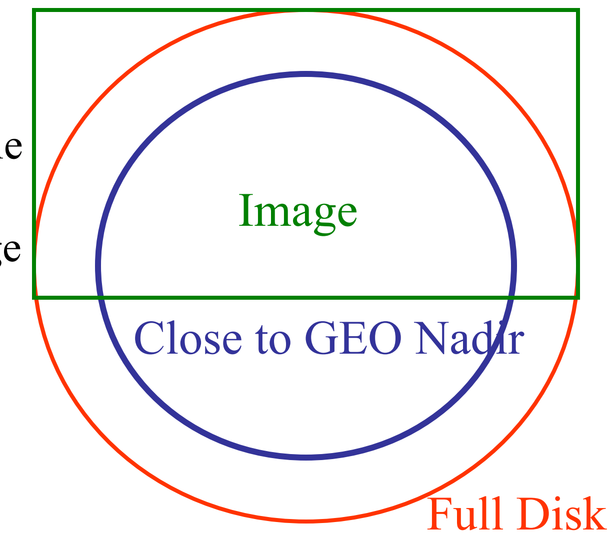
ATBD Design – Summary

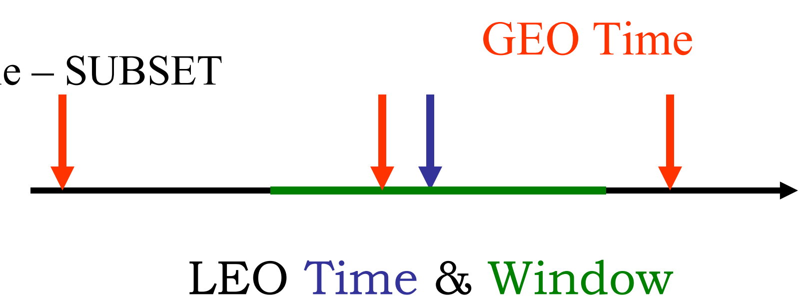
- GSICS goals require that single pixel collocations anywhere within the GEO field of regard be collected continuously over long term for all bands.

- GSICS should collect all it can to allow future selection and manipulation by users.

Implementation – Subsetting

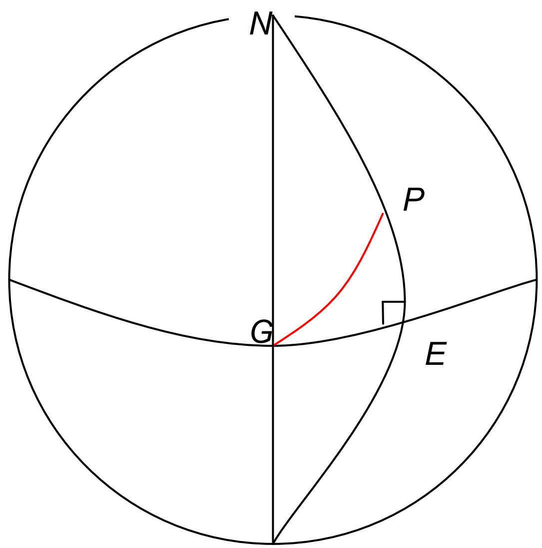
```
for each LEO granule
    for each GEO image
                CLOSE TO GEO NADIR
        if LEO granule is outside of GEO FOR then next granule
                WITHIN GEO IMAGE
        if LEO granule is outside of GEO image then next image
                CONCURRENT IN TIME
        time_diff = LEO_time – GEO_time
        if time_diff > max_sec then
            this image is too early – next image
        else if time_diff < -max_sec then
            this image (and the rest) is too late – next granule
        else
            this image matches the granule – SUBSET
        end
    end (next GEO image)
end (next LEO granule)
```

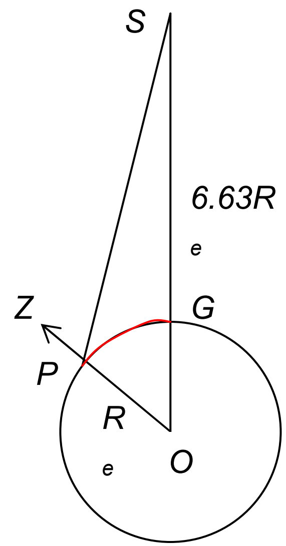




Implementation – Subsetting

Cosine theorem of spherical trigonometry





Cosine and sine theorems of plane trigonometry

GP = ∠SOZ

$$\cos(GP) = \cos(gra\_ctr\_lat)\cos(geo\_nad\_lon - gra\_ctr\_lon)$$

$$SP^2 = SO^2 + OP^2 - 2 * SO * OP\cos(PG)$$

$$\sin(SPZ) = \sin(PG) * SO / SP$$

Implementation – Collocation

for each LEO pixel

COLLOCATED IN SPACE

if LEO pixel is outside of GEO image then next LEO pixel

CONCURRENT IN TIME

if $|$LEO_time – GEO_time$|$ > max_sec (300 sec) then next LEO pixel

ALIGNED IN LINE-OF-SIGHT

if $|$cos(geo_zen)/cos(leo_zen)-1$|$ > max_zen (0.01) then next LEO pixel

UNIFORM ENVIRONMENT

if env_stdv > max_stdv (10 count) then next LEO pixel

NORMAL GEO FOV

if $|$fov_mean – env_mean$|$ > (env_stdv/n)(N-n)/(N-1)*G (3) then next LEO pixel

SPATIAL AVERAGING

simple average of GEO pixels in area comparable of LEO FOV

SPECTRAL CONVOLUTION

several choices

OUTPUT THE RESULTS

list of parameters provided

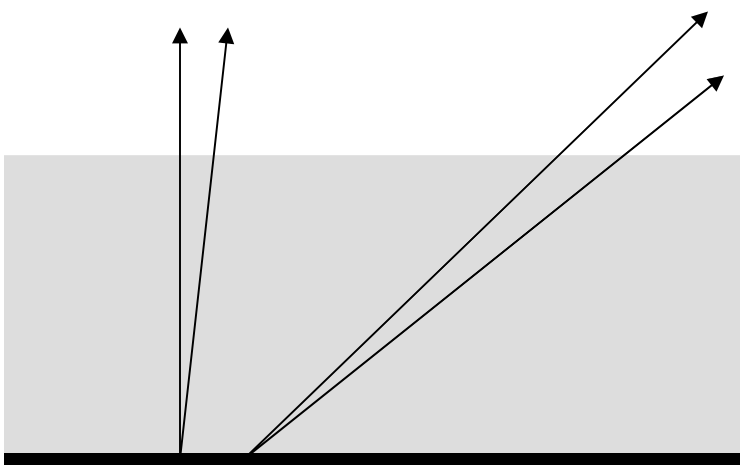
end (next LEO pixel)

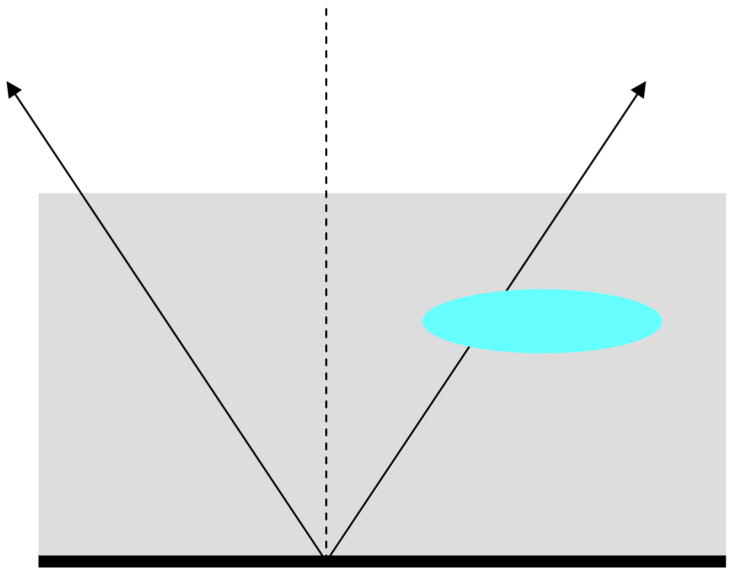
Implementation – Collocation Angle

$|geo\_zen - leo\_zen|$

$|sec(geo\_zen) - sec(leo\_zen)|$

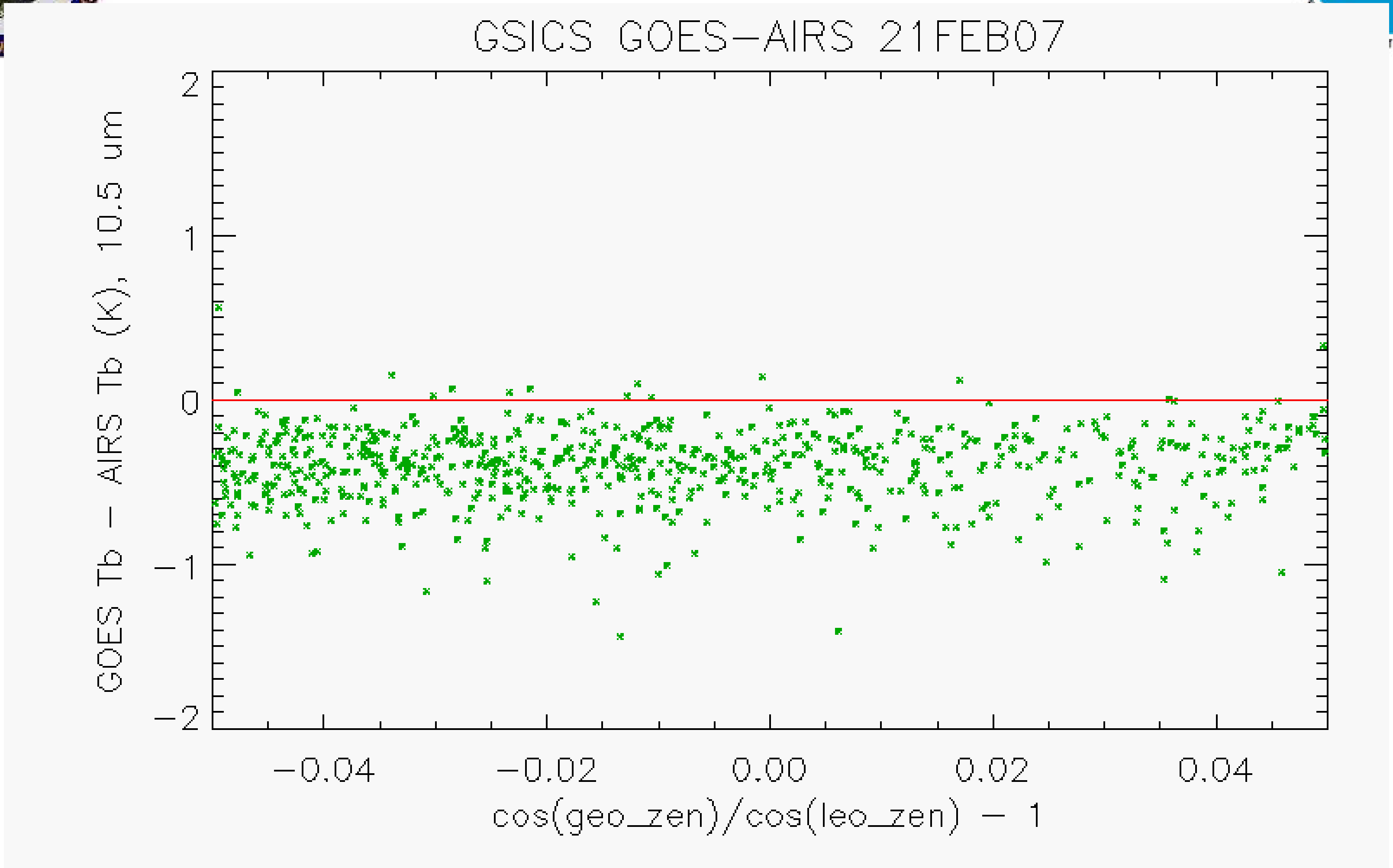
$|cos(geo\_zen)/cos(leo\_zen)-1|$



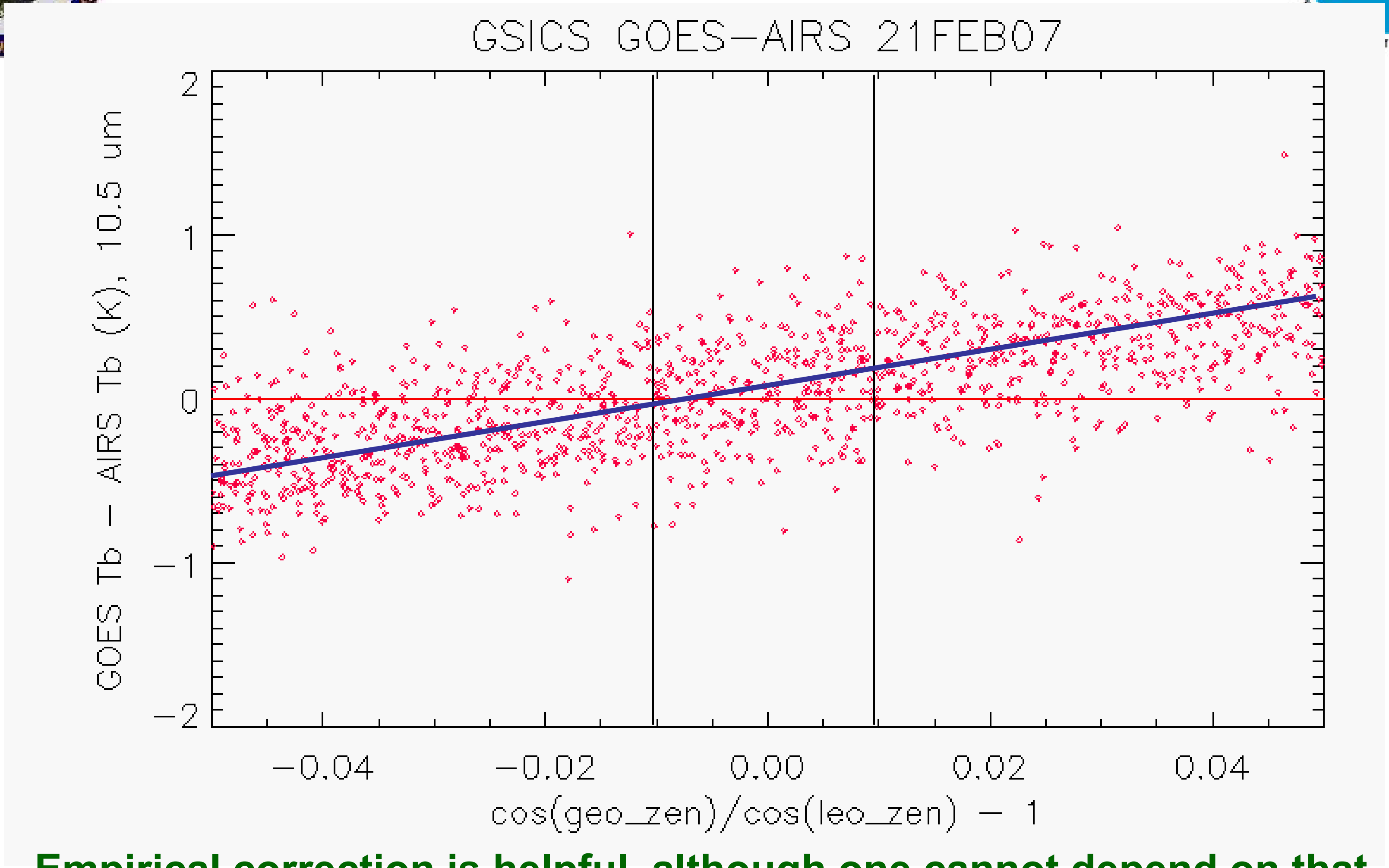


IR channels are often insensitive to difference in azimuth angle

Preliminary Results from Prototype Algorithm

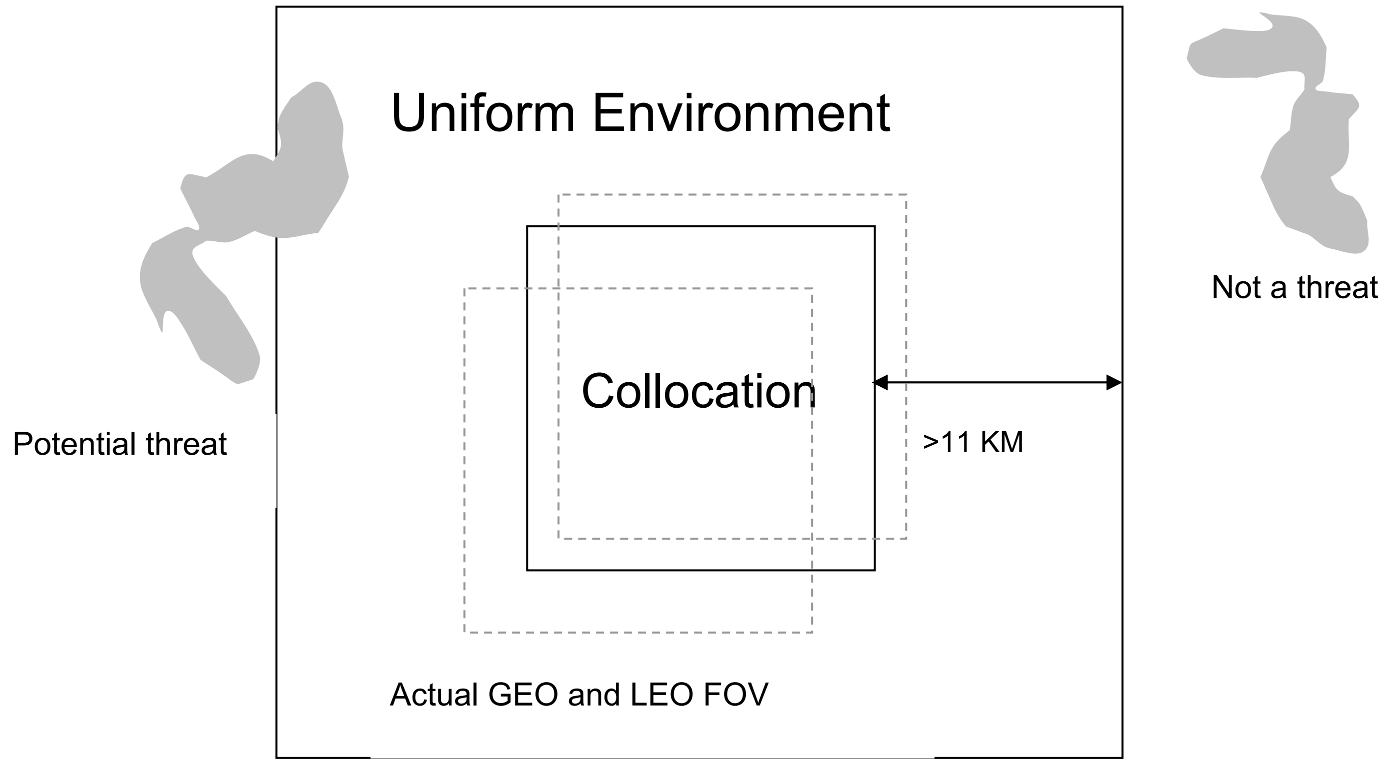


Preliminary Results from Prototype Algorithm

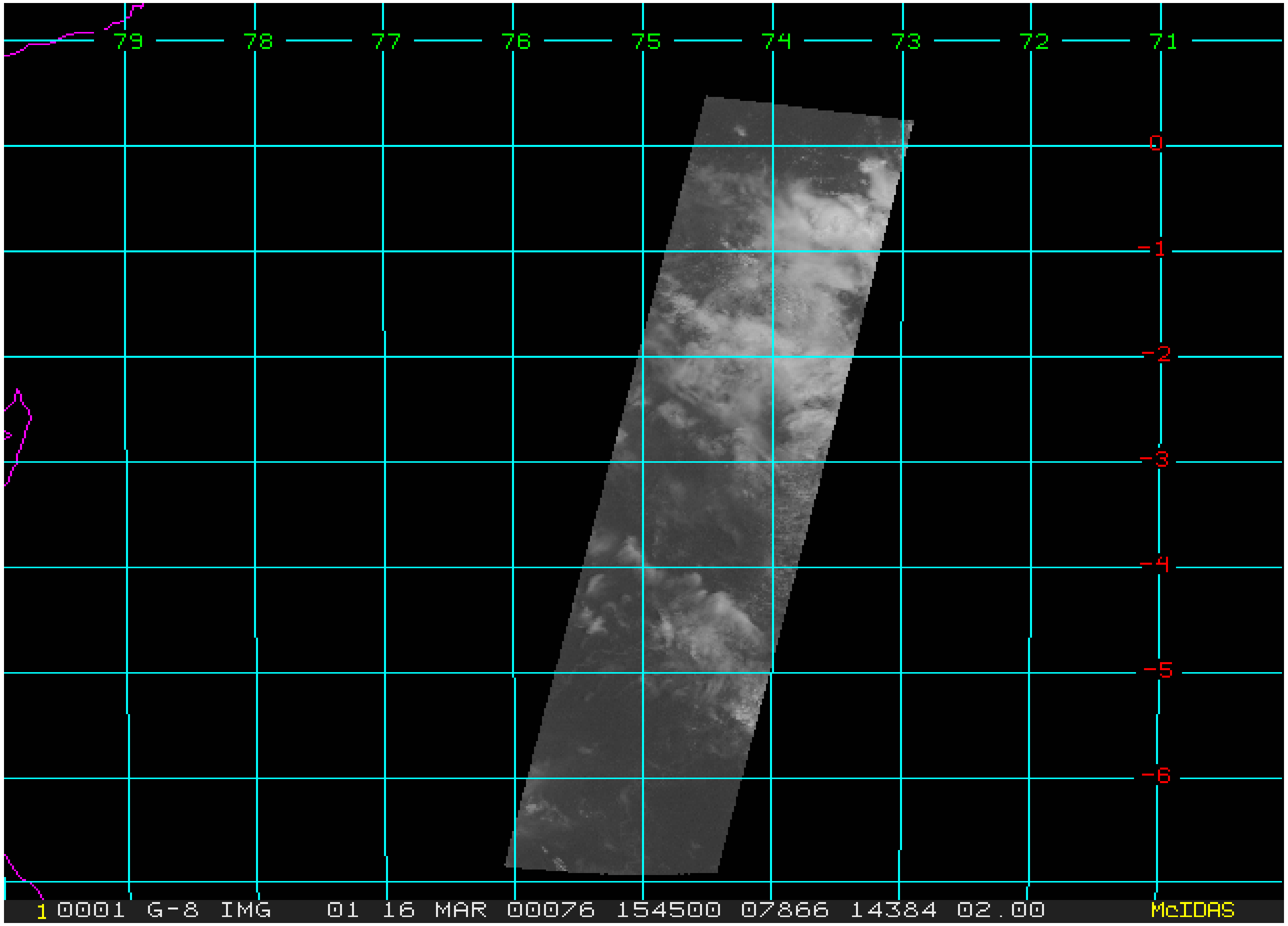


Empirical correction is helpful, although one cannot depend on that too much since this correction depends on the lapse rate

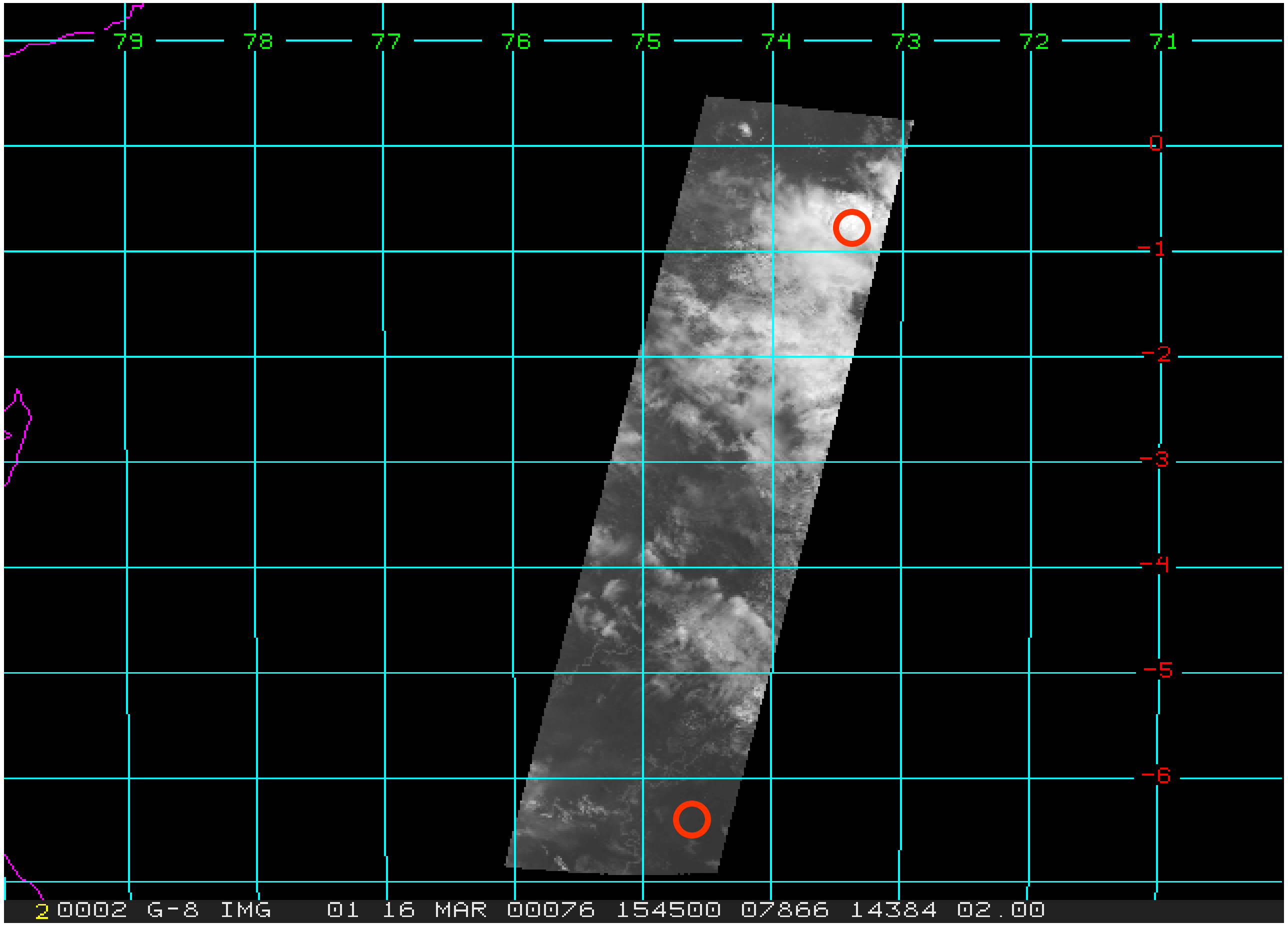
Implementation – Collocation Uniform



Preliminary Results from Prototype Algorithm



Preliminary Results from Prototype Algorithm



Implementation – Collocation Uniform

- Uniformity measured by standard deviation σ
- σ of T_b is not a good choice.
- σ of radiance is better.
  - Varies with scene T_b and wavelength – weighted by mean

Table 1: δT_b in response to 5% δR for GOES IR channels at selected scene temperature.

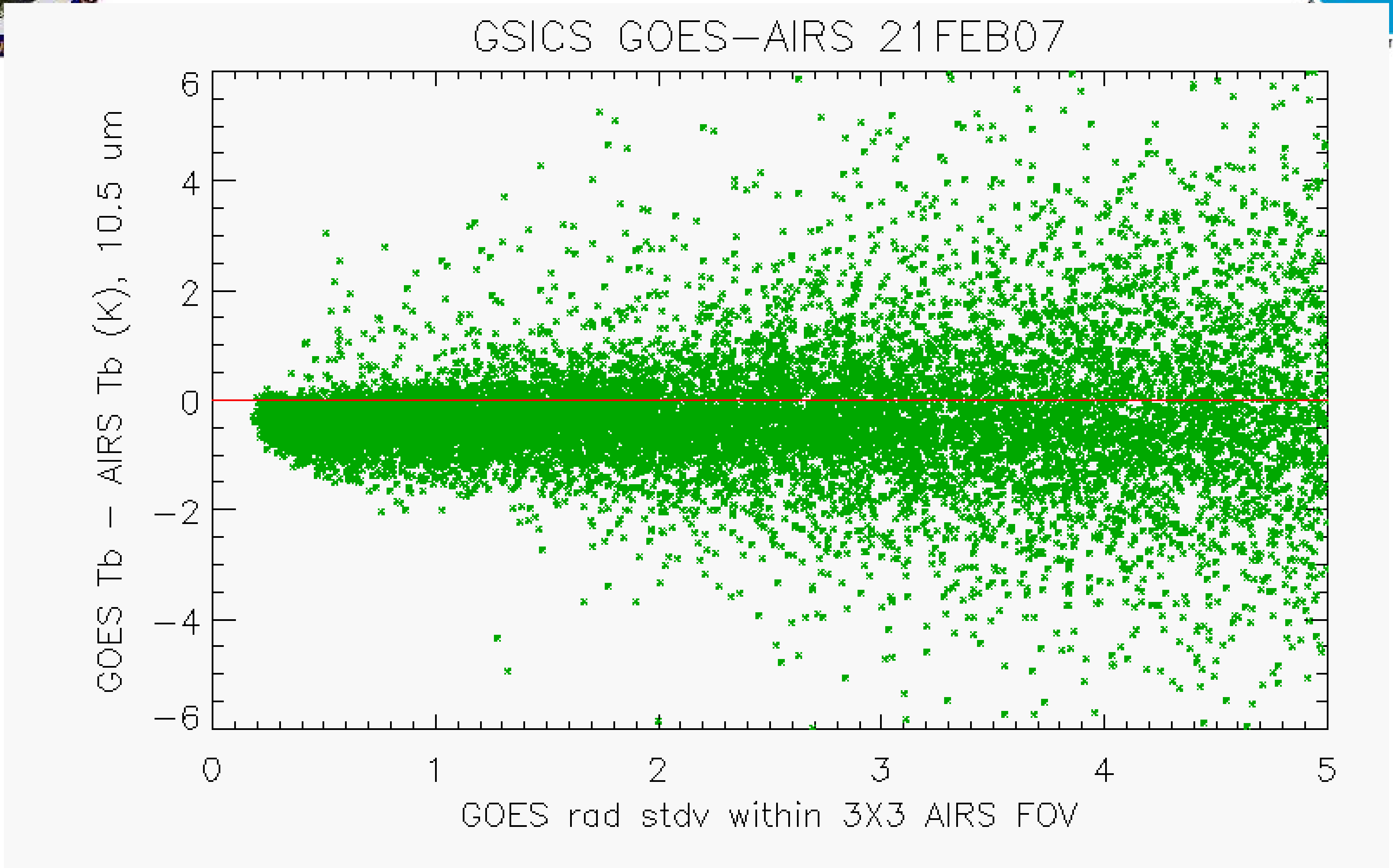
	3.9 μm	6.6 μm	10.7 μm	12.0 μm	13.3 μm
290ºK	1.2K	2.0K	3.1K	3.6K	3.9K
250ºK	0.9K	1.5K	2.4K	2.7K	2.8K
210ºK	0.6K	1.0K	1.5K	1.8K	2.0K

Implementation – Collocation Uniform

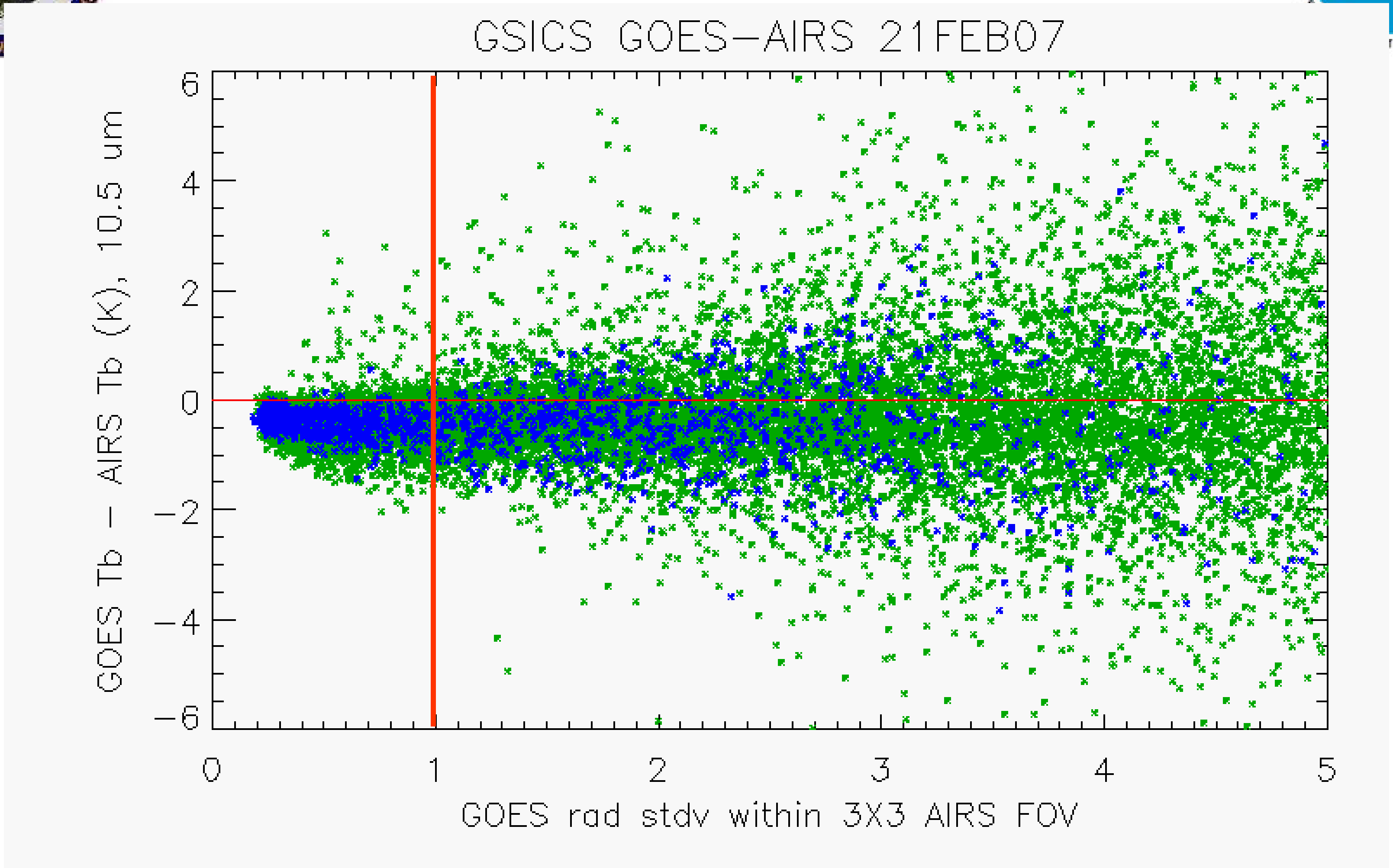
- σ of count is the best

Table 2: δT_b in response to 10 counts for GOES IR channels at selected scene temperature.

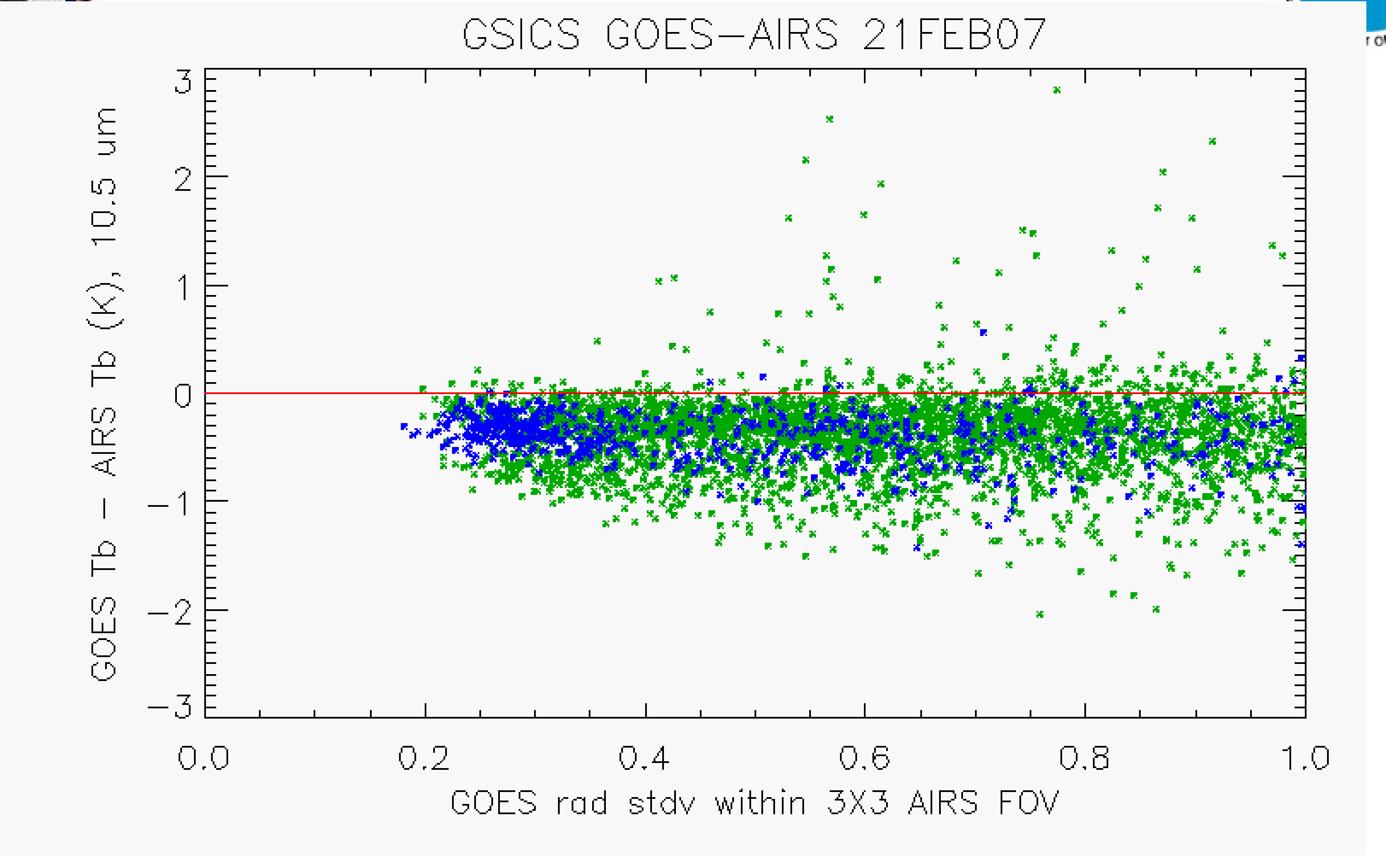
	3.9 μm	6.6 μm	10.7 μm	12.0 μm	13.3 μm
290ºK	1.6K	0.5K	1.2K	1.2K	1.1K
250ºK	7.5K	1.1K	1.9K	1.8K	1.5K
210ºK	27K	3.8K	3.7K	3.1K	2.4K



GSICS GOES–AIRS 21FEB07
GOES Tb – AIRS Tb (K), 10.5 um
6
4
2
0
–2
–4
–6
0
1
2
3
4
5
GOES rad stdv within 3X3 AIRS FOV

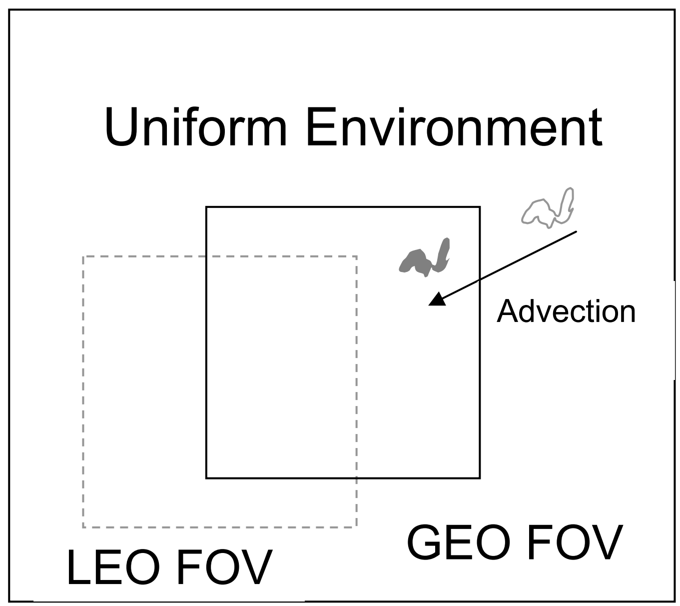


Blue: time difference < 60 seconds


GSICS GOES–AIRS 21FEB07
GOES Tb – AIRS Tb (K), 10.5 um
3
2
1
0
–1
–2
–3
0.0
0.2
0.4
0.6
0.8
1.0
GOES rad stdv within 3X3 AIRS FOV

Implementation – Collocation Normal

$$\left| \frac{1}{n^2} \sum_{i=1}^{n^2} R_i - M \right| \le \frac{S}{n} \frac{N-n}{N-1} Gaussian(=3)$$



Implementation – Collocation Averaging and Convolution

- Spatial average of GEO radiances

$$R_{GEO} = \frac{1}{n^2}\sum_{i=1}^{n^2} R_i$$

- Spectral convolution of LEO radiances

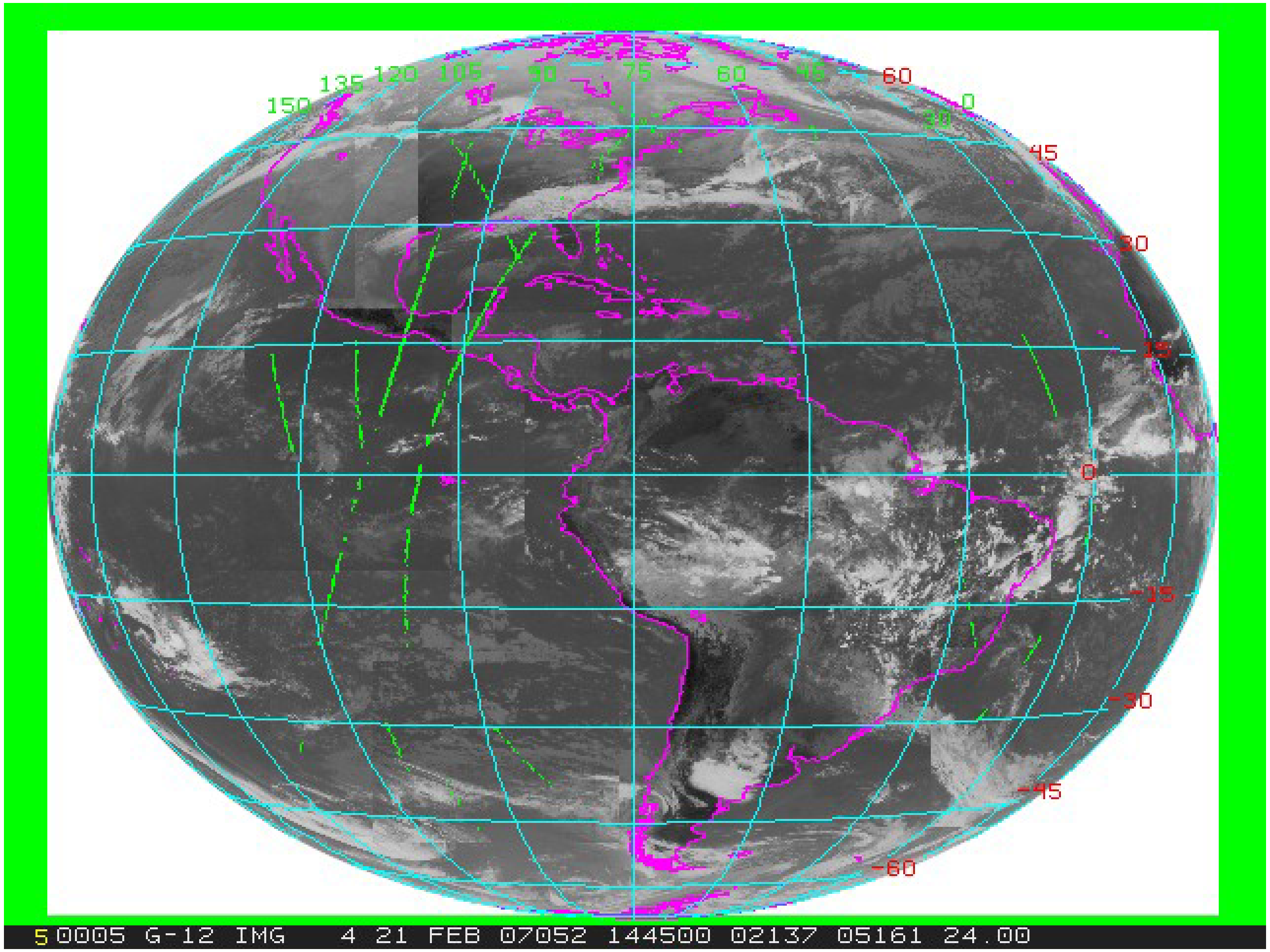
$$R'_{GEO} = \frac{\int_\nu R_\nu \Phi_\nu d\nu}{\int_\nu \Phi_\nu d\nu}$$

Implementation – Output Results

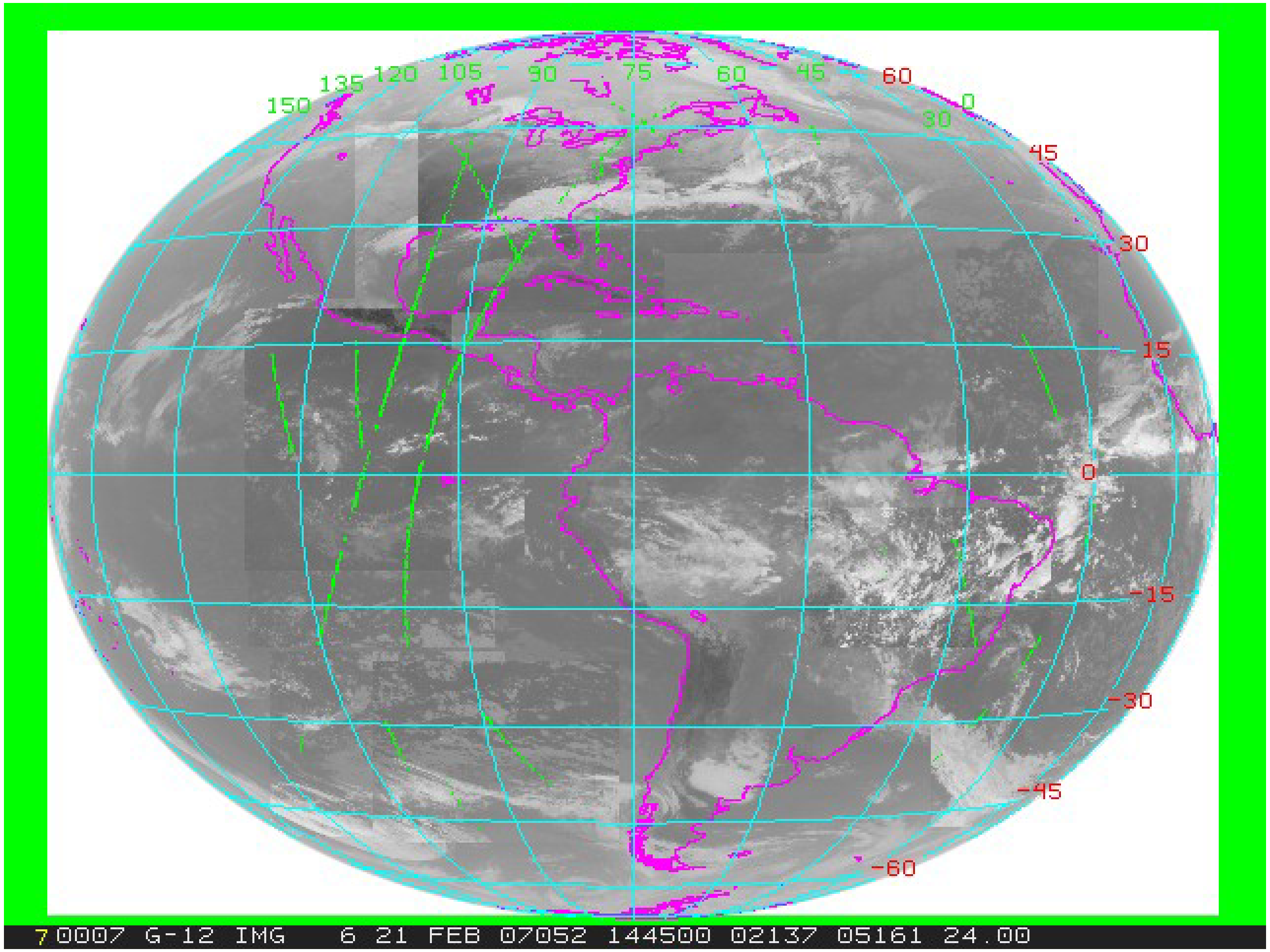
Real * 4	yyddd	year and day of year
Real * 4	hhmmss	hour/minute/sec of GEO observation
Real * 4	time_diff	LEO_time – GEO_time (sec)
Real * 4	zeni_diff	cos(θGEO)/cos(θLEO) - 1
Real * 8	time	LEO time of observation (TAI second)
Real * 4	latitude	collocation latitude (degree east positive)
Real * 4	longitude	collocation longitude (degree north positive)
Real * 4	geo_zen	GEO zenith angle (degree)
Real * 4	leo_zen	LEO zenith angle (degree)
Real * 4	sol_zen	SUN zenith angle (degree)
Real * 4	geo_azi	GEO azimuth angle (degree)
Real * 4	leo_azi	LEO azimuth angle (degree)
Real * 4	sol_azi	SUN azimuth angle (degree)
Real * 4	airs_cnv_shift	Ch6 shift SRF (irrelevant in general – to be deleted)
Real * 4	airs_mmg_shift	Ch6 shift SRF (irrelevant in general – to be deleted)
Real * 4	stat(6,4)	mean & stdv of collocation environment, mean & stdv of collocation target, convoluted AIRS radiance using modified Kato and Gunshor methods, for four channels
Real * 4	leo_rad(2378)	AIRS spectral radiances at 2378 channels
Real * 4	geo_rad(17,9,4)	GEO rad at 17 elements, 9 lines, and 4 channels

Further discussion after break

GOES 10.7 µm Co-locations with AIRS, 21feb02



GOES 13.3 µm Co-locations with AIRS, 21feb02



All bands data saved even if only one band qualifies for collocation